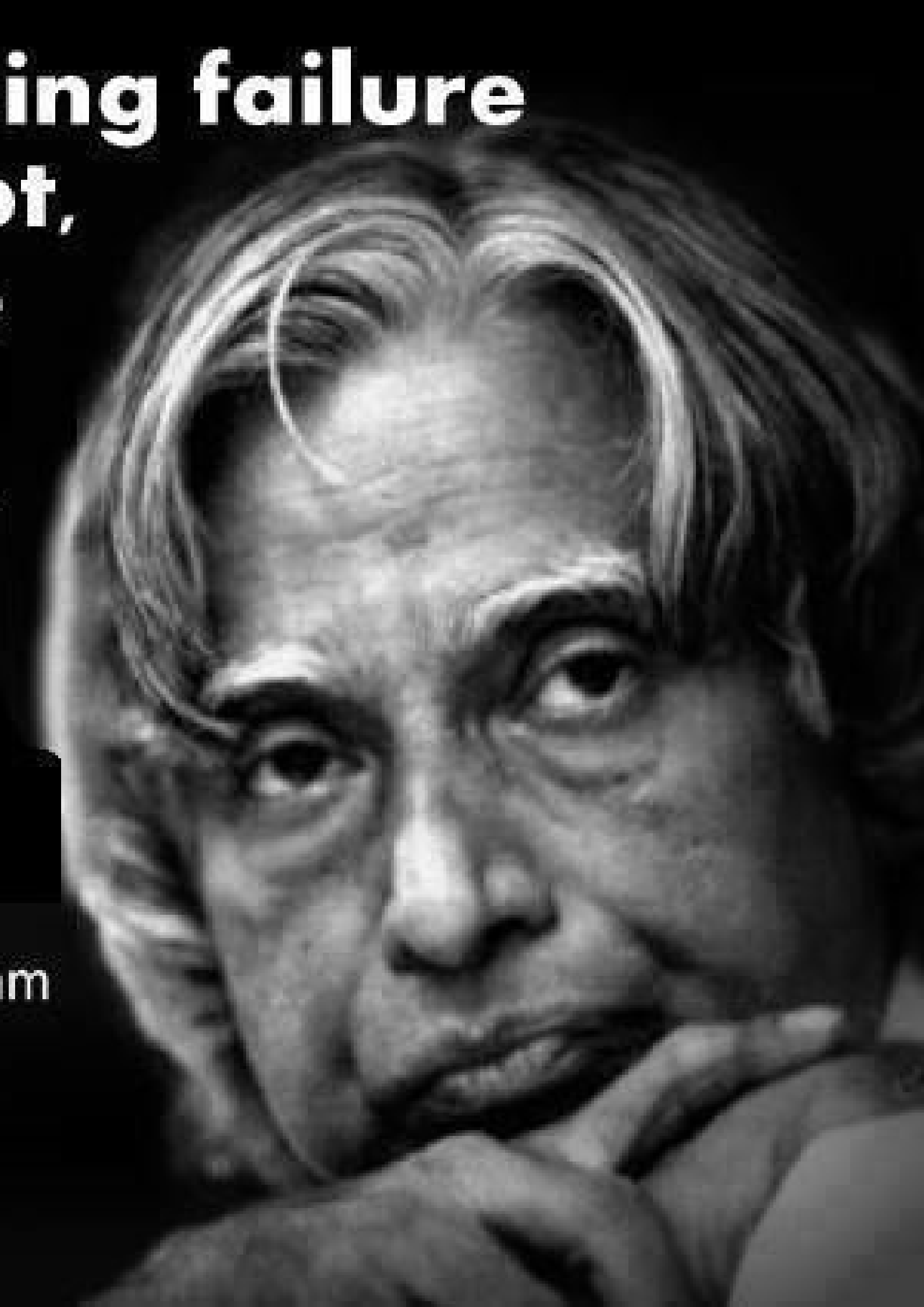
O-Engineers

Oct-2017,3rd Issue

2KW/Human
(Page 18)

"Dont fear for fac
in the first attemp
because even the
successful
Maths starts with
'zero' only"

- A. P. J. Abdul Kala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This is our 3rd edition of O-Engineers,we are working hard to bring best available engineering material for our engineering community, we are taking every reader's feedback seriously and making possible amendments in every upcoming edition of the magazine, but lot of improvements and changes we still have to incorporate in our magazine, and now we are realizing meaning of famous tag line "Only thing that is constant in life is CHANGE", Our Article Writers are Engineers, we do not ask for their years of experience in their field but interested in their will to spread knowledge, we hope this journey of learning will continue for suitable time.

Engr. Qazi Arsalan Hamid
Editing Engineer

Contents

Feedback

Very good effort . Waiting for 3rd edition

(Aamar Hamid)

its quite informative and good job

(HamedUllah)

You are working hard. May allah help you

(Hazrat Ali)

More informative, kindly remove the background you have inserted some different images. thank you for sharing but one page should define the problems of engineers current & solution also give suggestion to PEC to improve & safe the engineers future just like doctor house job etc.

(Wasim Sajjad)

Complete rewinding or partial repairs on Large Motors

Engr.Irfan Akher

Well, this is a tricky question to answer. We need to look at different results like Core Loss, Tangent delta and partial discharge in this case. But we do need to segregate the areas where the condition is really bad and might as well be contributing to overall poor results. For example, a Grounded Specimen Testing of the motor tells you the health of insulation to ground mainly. Where as Ungrounded Specimen Testing covers the End winding area.As we know we can perform physical inspection, carry out re-bracing on the end winding, partial insulation repairs, revarnishing, adjustment of spacers and re-wedging to help us. Whereas, there is little that can be done if ground wall insulation is damaged in the core portion.

Also important to note is the importance of Tan delta at 0.2PU and the tip up. Initial tan delta at 0.2PU tells us a lot about the quality of motor manufacturing and what to expect. Setting a baseline of these values and then trending might lead us to precisely knowing when to do refurbishment or repair.

Similarly for 6.6 + KV rated motors, Partial Discharge testing is also helpful in decision making. There are certain PD types that are HIGH RISK as compared to end winding discharges which are of medium to low risk. An experienced engineer will look at the patterns with regards to phase angles, symmetry and pulses frequency to make an educated estimate of severity and location of discharges. If PDs are in groundwall insulation in a slot, then very little can be done.

Hence with Tangent delta and Partial Discharge testing, using GST/UST and PRPD interpretation, we can decide if partial repairs can be done or complete rewinding is needed.

Similarly, if a motor has actually had an earth fault and burnt, we may need to look at the extent of damage done to core through ring flux method. The motor may run with additional losses on repair and may have a hot spot at the place where previous earth fault took place.

It is a case of weighing the pros and cons of replacing an old inefficient motor with a new efficient motor with a cost difference of 40 to 50%. If payback based on total cost of ownership is less than 2 or 3 years, it is advisable to replace the motor.

Conclusion:

We have to look beyond the numbers provided by Testing Engineer and if needed carry out physical inspection, design documents, O&M history, and take into consideration the total cost of ownership. Of course, decision making is not so easy for the maintenance engineer unless he has all the information instead of being flooded by data and numbers.

Dynamic Response of Synchronous Generator's Static Excitation System during Power System Abnormalities

Engr. Syed Raza Hussain

ABSTRACT:

This paper offers an approach for the application of a Fuzzy based AVR Controller being applied to a closed loop Static Excitation System for precise controlling of field voltages of a large synchronous generator. The Excitation System is modeled using Matlab/ Simulink® by utilizing ST1A model for potential source excitation system normally called static excitation system. The proposed fuzzy based excitation system has been significantly used in system's dynamic and transient states including system fault conditions, i.e. LG, LLG & LLLG faults.
This design of FLC requires uses the basic concepts of control system and as per achieved results it is recommended that using fuzzy based excitation system the network side sudden requirement of reactive power can be managed with minimizing the fault settling time and decrease in the % overshoot which will be helpful for the elimination of voltage collapse initiation.
Keywords: Fuzzy Logic Control, Static Excitation System, PID controller, stability.

Electrical power network consists of synchronous generators operating in perfect synchronism [1]. Whenever a system is subjected to any kind of disturbance, there is a tendency for the system to collapse, if not properly govern by the control systems. The excitation and governing controls of generator are helpful in improving stability of power system. Typically, the excitation control and governing control are designed independently [10]. In this paper our discussion mainly covers the stability aspects of excitation system controllers. Excitation systems are one of the most important parts of the synchronous generators [9]. The essential function of excitation system is to provide DC supply to the field windings of a synchronous machine [3]. Usually it consists of autonomic voltage regulator (AVR), exciter, measuring elements, power system stabilizer (PSS) and limitation and protection unit [4]. To deliver active and reactive power at different loading conditions a precisely regulated DC controller is required to control field voltages of synchronous generator. The synchronous generator deliver loads to different consumers large induction loads, hence ceiling capability of exciter system is required to operate transiently with voltage levels that are 3 to 4 times the normal value. High field forcing is directly achieved in static excitation system where this requirement has been fulfilled by dedicated power transformer, in static (ST) excitation systems all the elements are stationary [1]. Below are the systems with their responses presented in the Table1 [1].

The performance of the excitation system can have a great influence on the stability of a power system [6]. As under steady state conditions, the P.U values of E_fd and I_fd are equal. During a transient condition, however E_fd & I_fd differs. E_(fd) is determined by the excitation system and I_(fd)is determined by the dynamics of the field circuits.

To study the behavior of synchronous generator regarding power stability, it isnecessary that excitation systems should be modeled, so that it can be analyzed. And as discussed the desired model should be appropriate for signifying the actual excitation system for large/ severe abnormalities as well as for small changes in the network.

Table 1: Comparison of different types of exciters

Parameter	DC	AC		ST
		Stationary	Brushless	
Excitation Supply	Small transformer	Small transformer	Small transformer	Transformer
Length of machine	Medium	Medium	Medium	Short
Response time	Slow	Medium	Medium	Very fast
Components requiring maintenance	slip ring and commutator	Slip ring	-	Slip rings
De-excitation	Medium	Medium	Slow	Fast

ST1A exciter model represents a potential source controlled-rectifier system. The excitation system is powered up by excitation transformer from generator terminals.

The model shown in fig. 1 is satisfactorily adaptable to represent transient gain reduction employed either in the forward path via time constants TB and TC or in the feedback path by correct selection of degree in response feedback parameters i.e. KF and TF. Regulator gain of voltages and any integral time constant of excitation system are denoted by KA and TA, respectively.The consequence of rectifier regulation on ceiling voltage is represented by KC.

The model provides flexibility to represent series lag-lead or feedback stabilization.

Excitation system plays important role in improving power system stability, as it is a matter of fact that the "steady-state" limits of power networks could only be increased by using the available high-gain continuous-acting fast voltage regulators. Furthermore, it has been shown that the any discrepancy in the shorter time period may tend to cause instability afterwards. This proposes the split-up of the excitation control studies into two divergent problems, the transient (short-term) problem and the dynamic (long-term) problem.In transient stability the machine is exposed to a large influence, usually a fault, which is sustained for a short time and causes a significant

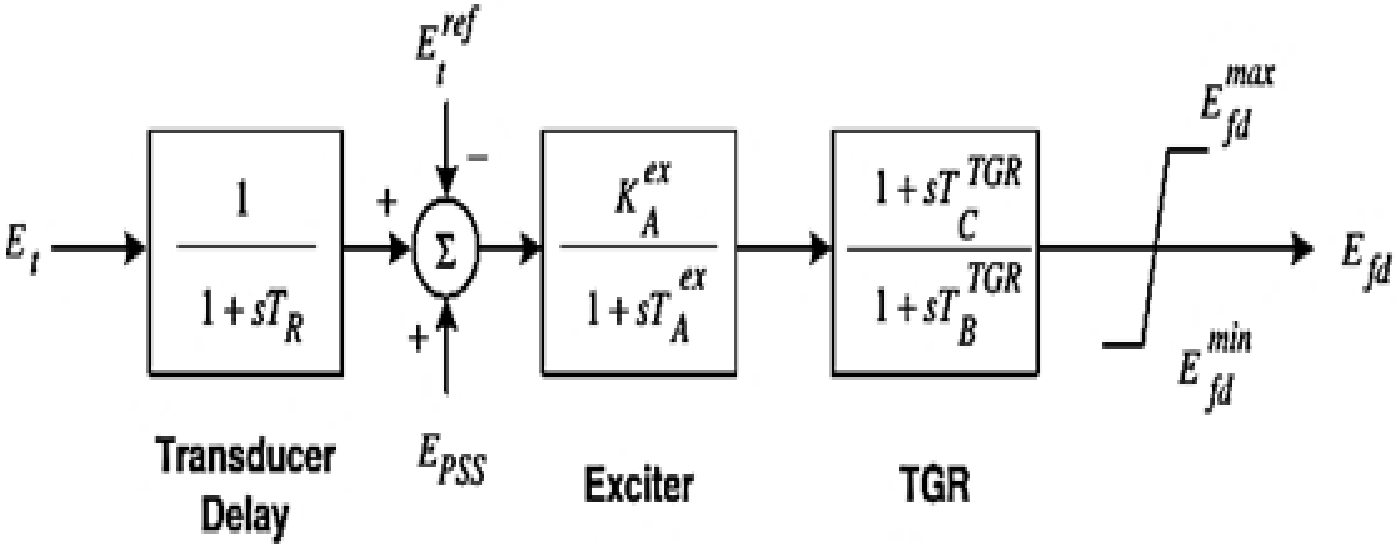

Fig. 1: Simplified block diagram for the IEEE Type ST1A static exciter

reduction in the machine terminal voltage and the ability to transfer synchronizing power. If we consider the one machine-infinite bus problem, the usual approximation for the power transfer is given by,

$$P = ((V_t V_\infty)/x)\sin \delta \text{----------}(1)$$

Where V _t, is the synchronous machine terminal voltage and V_∞ , is the grid voltage normally represent by infinite voltages.
The main advantage of the fuzzy logic controller (FLC) is that it can be applied to plants that are difficult to model mathematically, and the controller can be designed to apply heuristic rules that reflect the experience of human experts [5].
The designing of a Fuzzy Logic Controller mainly entails the choice of membership functions. The membership functions should be selected such that they cover the complete universe of discourse.
After the appropriate membership functions are chosen, a rule base should be created. It consists of a number of Fuzzy If-Then rules that completely define the behavior of the system.
These rules very much look like the human thought course of action, thus delivering artificial intelligence to the controlled system [7].To implement FLC (rule based) in ST1A we have used Fuzzy Logic Toolbox from MATLAB Simulink® [5].Figure 3 shows the ST1A model with fully loaded FLC controller. This ST1a block features built in function of field current and voltage limiter.
The inputs to the Fuzzy Logic Controller are:

1. Voltage Error (Ve).
2. Change in Error (dve/dt) or derivative of voltage error.

The rule base for deciding the output of the inference system consists of 49 If-Then rules; the table representing the rule base is as follows,

Table 2: Complete 49-fuzzy rules in tabular form

Ve / dVe/dt	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NBM	NM	NMS	NS	ZE
NM	NB	NBM	NM	NMS	NS	ZE	PS
NS	NBM	NM	NMS	NS	ZE	PS	PM
ZE	NM	NMS	NS	ZE	PS	PMS	PM
PS	NMS	NS	ZE	PS	PMS	PM	PBM
PM	NS	ZE	PS	PMS	PM	PBM	PB
PM	ZE	PS	PMS	PM	PBM	PB	PB

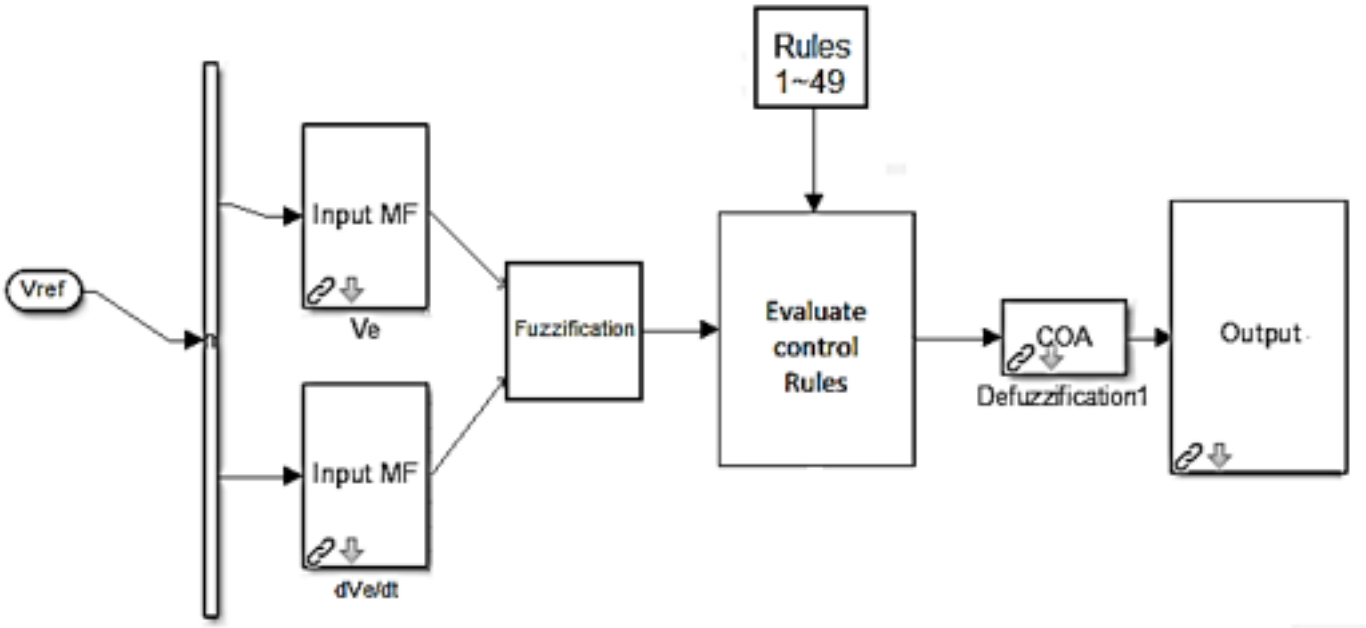

Fig. 2: Block diagram of fuzzy logic controller

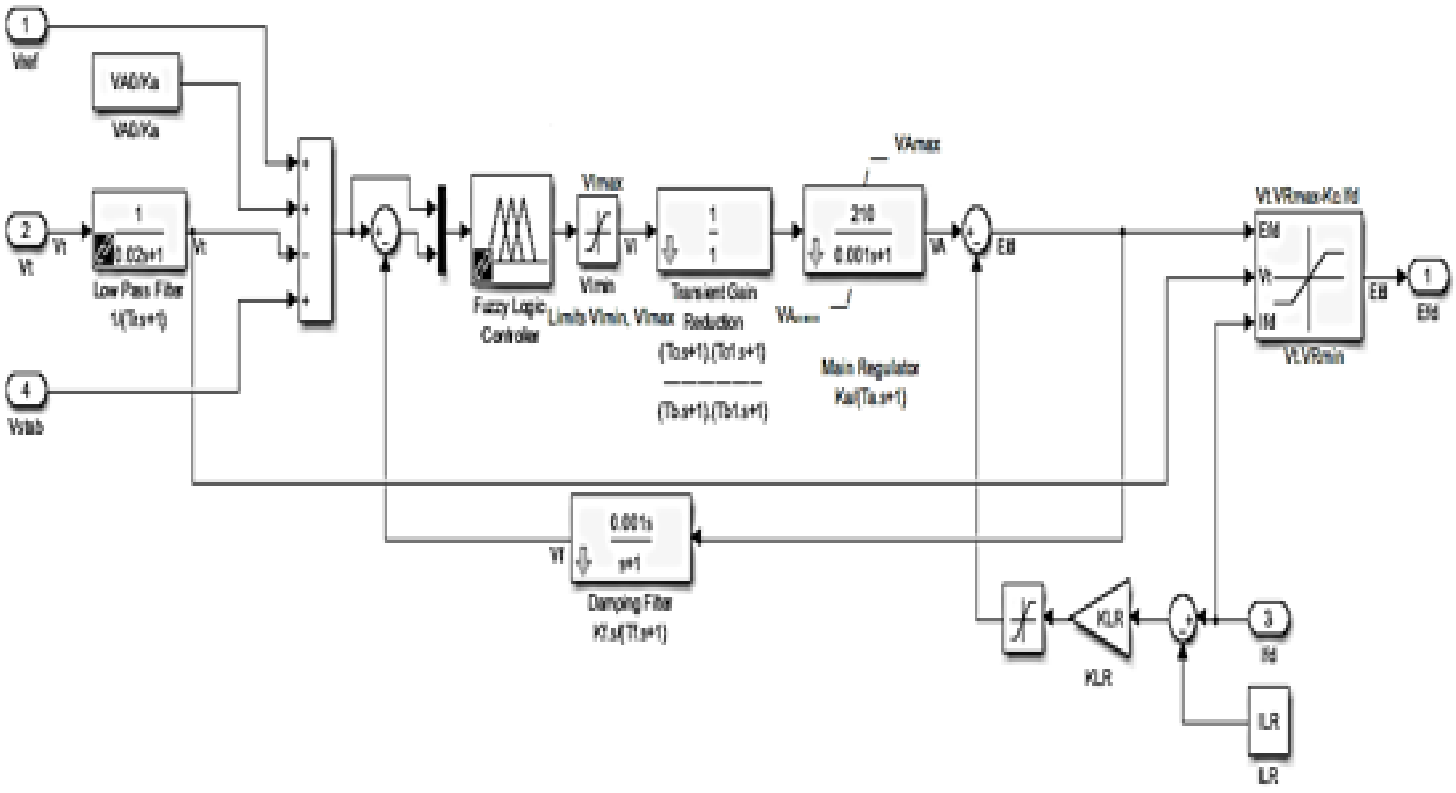

Fig. 3: FLC implementation in ST1A excitation system

While simulating the block diagram in MATLAB/SIMULINK®, the Fuzzy Logic Controller has to be programmed according to the aforementioned rules and knowledge base. The program is saved as an FIS file and it is later embedded into the fuzzy logic controller. This FIS program can be checked with the help of FIS editor in MATLAB itself.

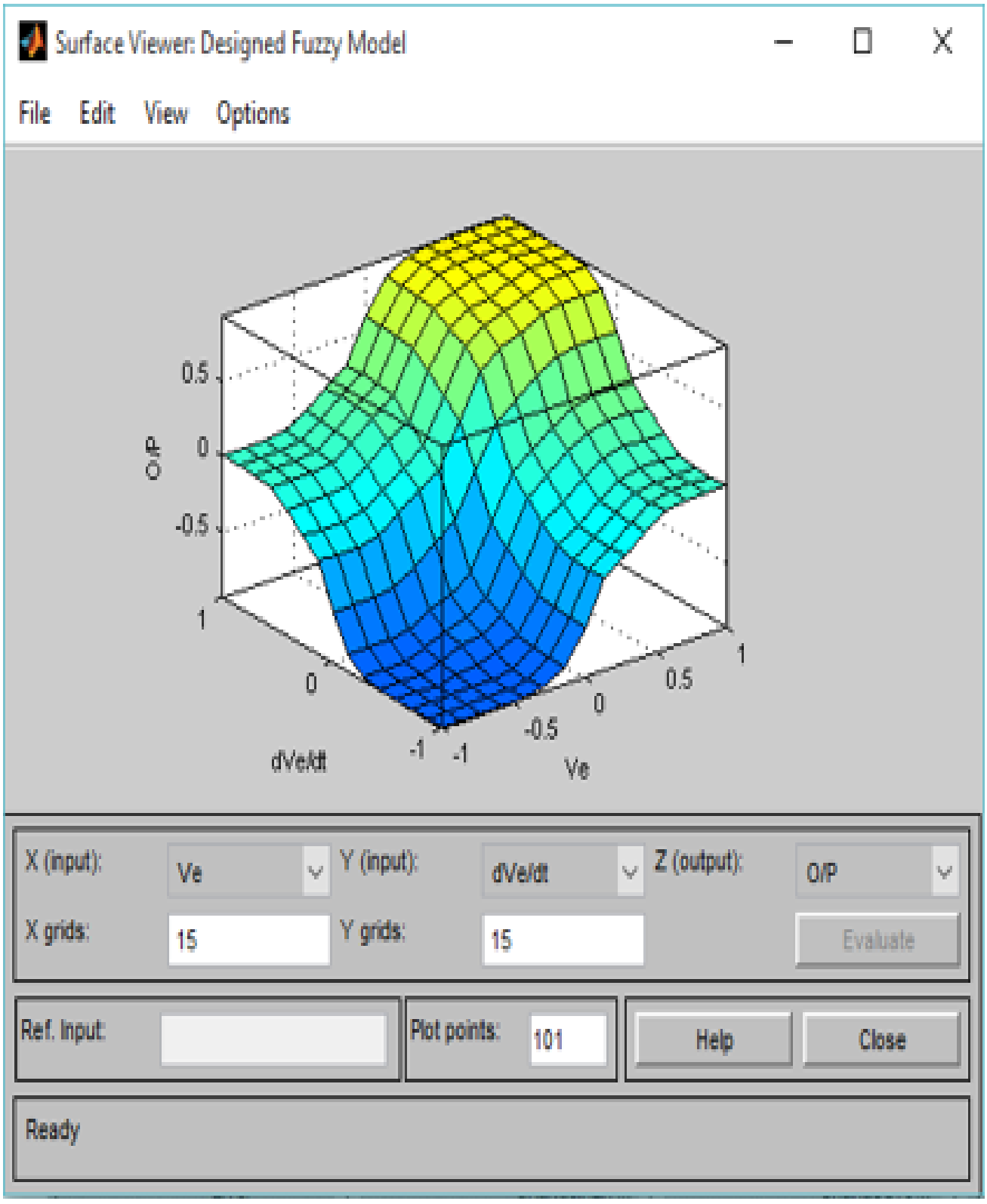

Fig. 4: 3-D plot of surface view

Fig. 5 shows the synchronous generator with Static ST1A based AVR connected to infinite bus. The synchronous generator data used in this thesis is somewhat modified actual generator data. Apparent power of the generator is 210 MW with output voltage 18 kV. Generator main parameters are as below; we will use 210MW active power and 50 MVAr reactive power. All used parameters are selected based on actual data. The generator and the network are modeled in Simulink.

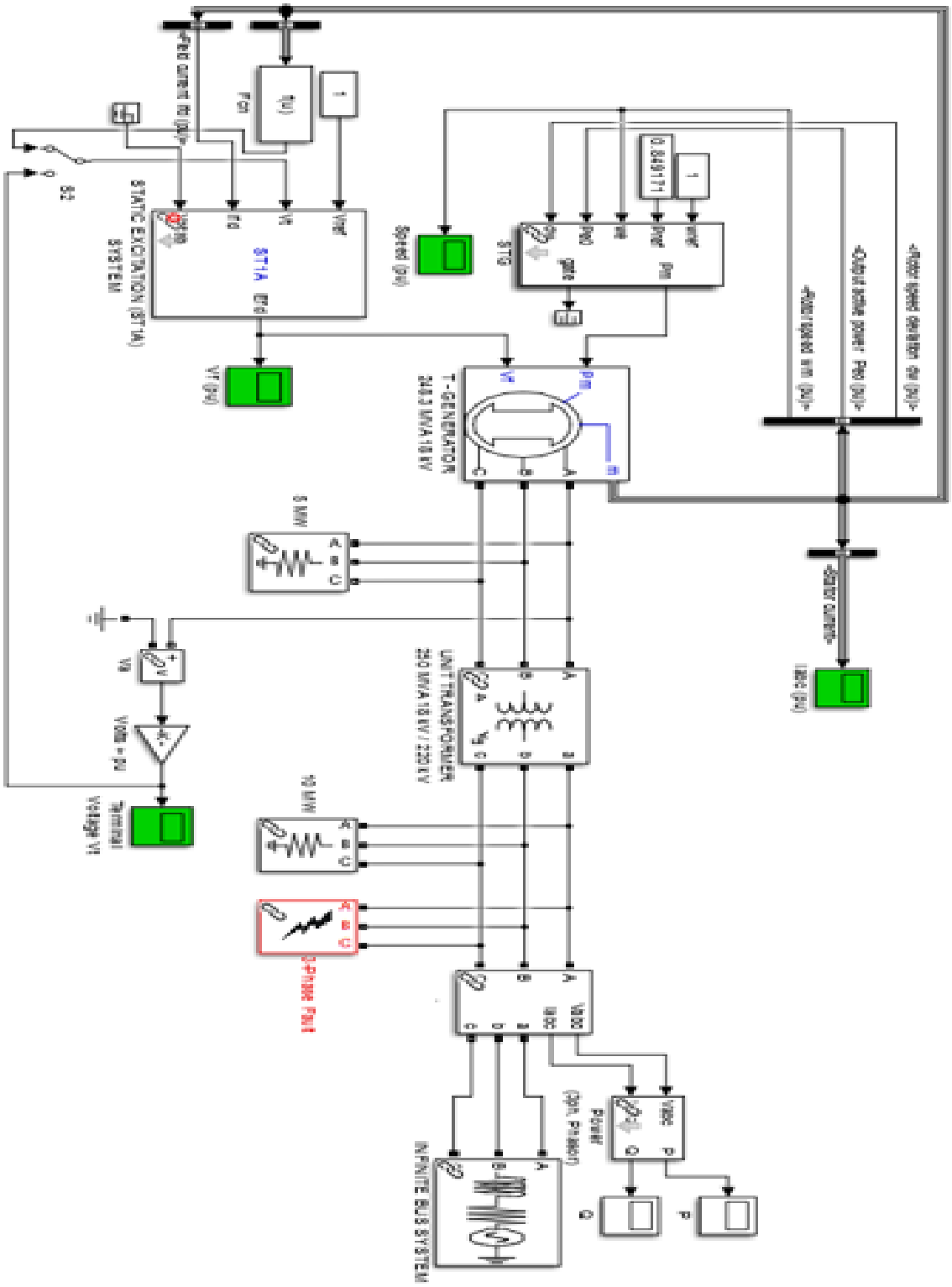

Fig. 5: Synchronous Generator with Static ST1A based AVR connected to Infinite Bus

Fig. 6 shows the comparison between PI & Fuzzy based AVR, we can see the output graphs of both controllers at rated loading of the machine which is 210MW and with the capability margin of the synchronous generator at 0.86p.f (lagging), the above graphs show the terminal voltage response of our simulated model in p.u. The settling time is high in PI based controller, as compared to fuzzy logic controller, below are the tabulated values of %overshoot and settling time of designed controllers.

From the above tabulated results this can be analyzed that the %overshoot of almost every controller is same concerning to dynamic stability. But the settling time have huge deviations and by utilizing fuzzy based ST1A model the settling occurred in only 0.2 second to 0.3 seconds from initial to rated loading of the machine.

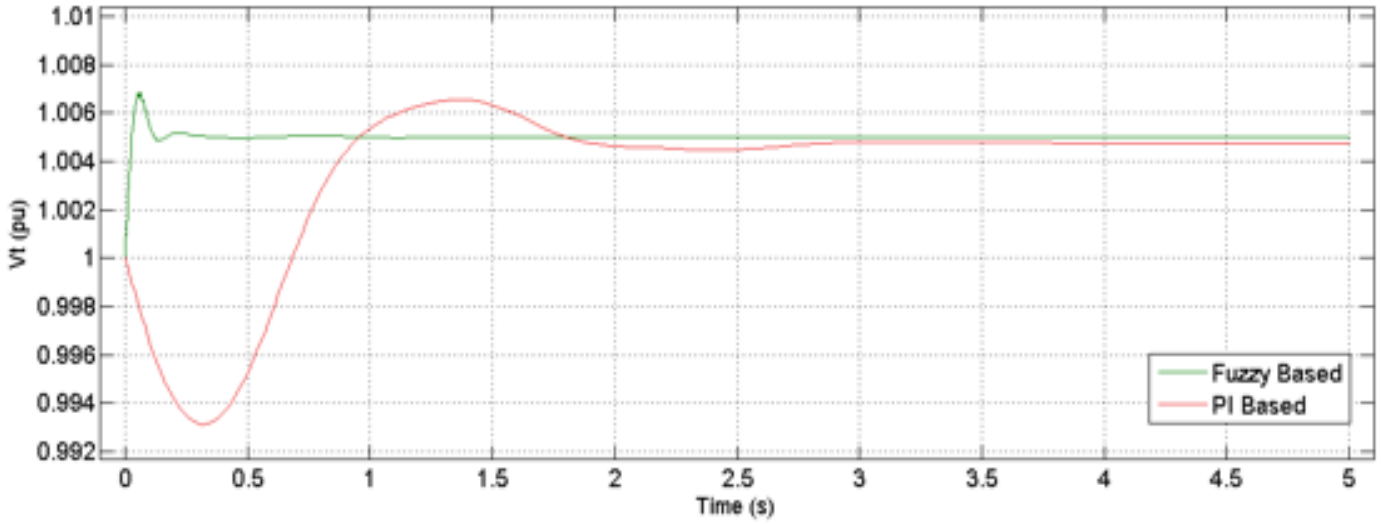

Fig. 6: Comparison between PI &fuzzy based AVR

Table 3: Dynamic response of PI and fuzzy based static excitation system: ST1A model

Controller	Loading	% Overshoot	Settling time
Conventional P type	At 210MW	1.002	4.0 s
PI based (tuned)	At 12MW	1.007	2.5 s
	At 210MW	1.009	3.0 s
Fuzzy based	At 12MW	1.001	0.2 s
	At 210MW	1.007	0.3 s

Transient stability of a system refers to the stability (generators remaining in synchronism) when subjected to large disturbances such as faults and switching of lines [6].

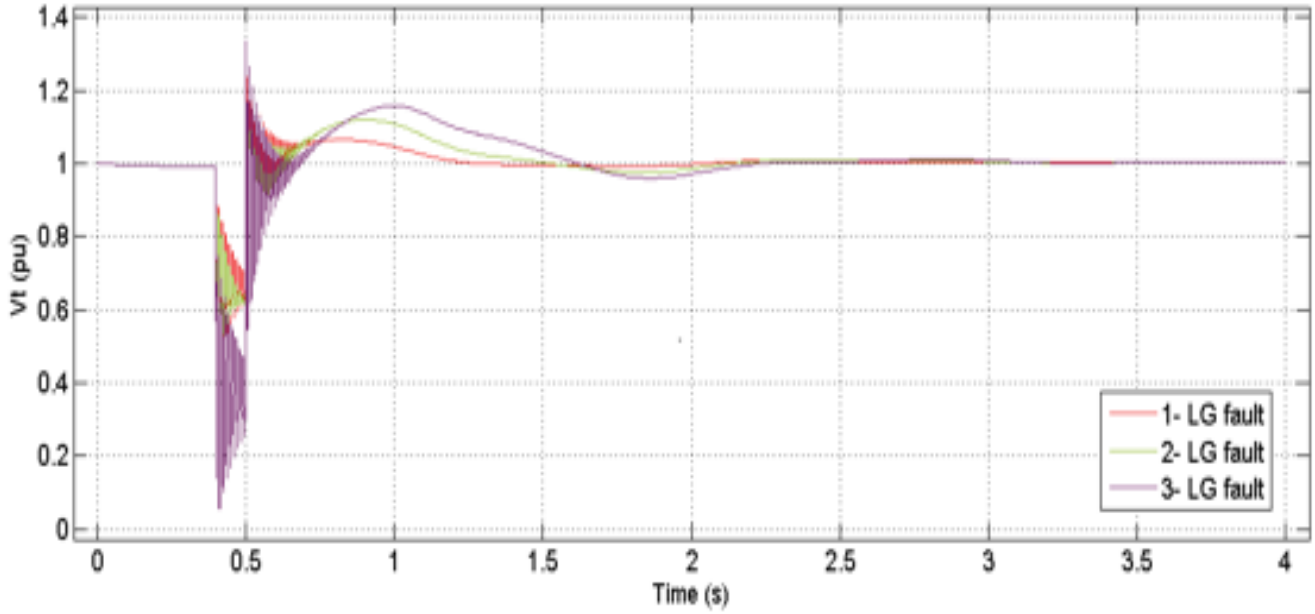

Fig. 7: Comparison of PI based faults

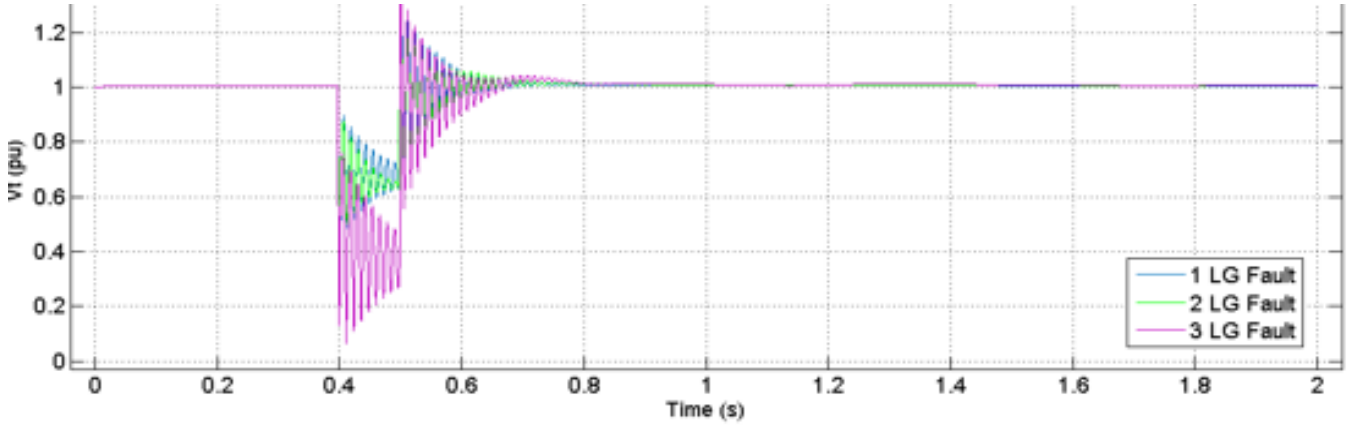

Fig. 8: Comparison of fuzzy based faults

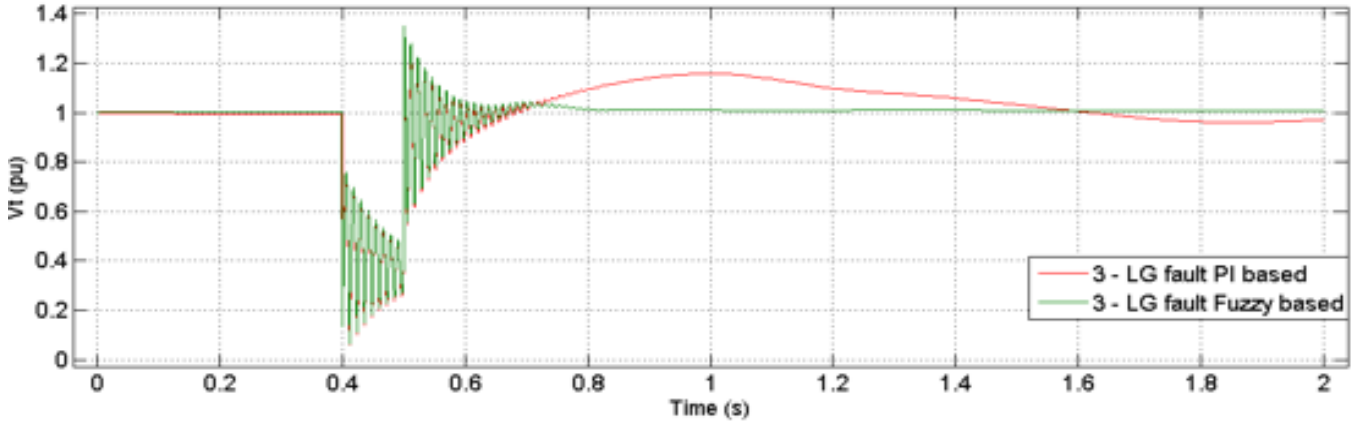

Fig. 9: LLLG fault comparison using PI and fuzzy AVR

This can easily be understood from the below tabulated results, we can analyze that the %overshoot of both controllers have almost same. But we can find huge variations in settling time, which gives the exactness of proposed FLC controller.

Table 4: Transient analysis of PI & fuzzy based static excitation systems

ST1A System	Fault Nature	% Overshoot	Settling time
PI based	1L-G	1.30	1.4 s
	2L-G	1.21	2.0 s
	3L-G	1.35	2.5 s
Fuzzy based	1L-G	1.28	0.3 s
	2L-G	1.21	0.4 s
	3L-G	1.32	0.45 s

CONCLUSION

This paper presents the modeling of static excitation system in Simulink. We have simulated PI & fuzzy logic controllers in ST1A model, the simulated responses of both controllers have been tested with initial and rated loading of large 210MW Turbo-Generator. From above graphs we can sum up that with PI based system there remain stability issues regarding power system security. However by utilizing fuzzy based AVR in excitation system can give power network more precise control of system abnormalities.

The main aim of this paper was to develop a model for power system stability during transients in a large power network like KE or WAPDA. In Pakistan mainly all thermal power plants which are the base load plant are mainly excited by conventional type of excitation systems, these systems are robust in nature but the response time required to cope up the system dynamics remains on higher side. By utilizing modern excitation system the initial power side variations due to dynamics of load can be controlled in precise manner.

We have tested the proposed model in all the abnormal situations which can be faced by generating stations. By analyzing PI and fuzzy based excitation system, this can be conceived that the best dynamic and transient stability can be achieved by utilizing fuzzy logic controller.

The main aim of this paper was to develop a model for power system stability during transients in a large power network like KE or WAPDA

RECOMMENDATION

Fuzzy logic provides a certain level of artificial intelligence to the controllers since they try to imitate the human thought process. This facility is not available in the conventional controllers.
After the simulation of the block diagram in MATLAB/SIMULINK® it was found that the fuzzy logic controller used in the simulation worked quite effectively. The advantages of the fuzzy logic controller used in the simulation were as follows:

The overshoots in the system was less as compared to conventional PI controller.

The settling time was very less.

The designing of the control mechanism was not very cumbersome.

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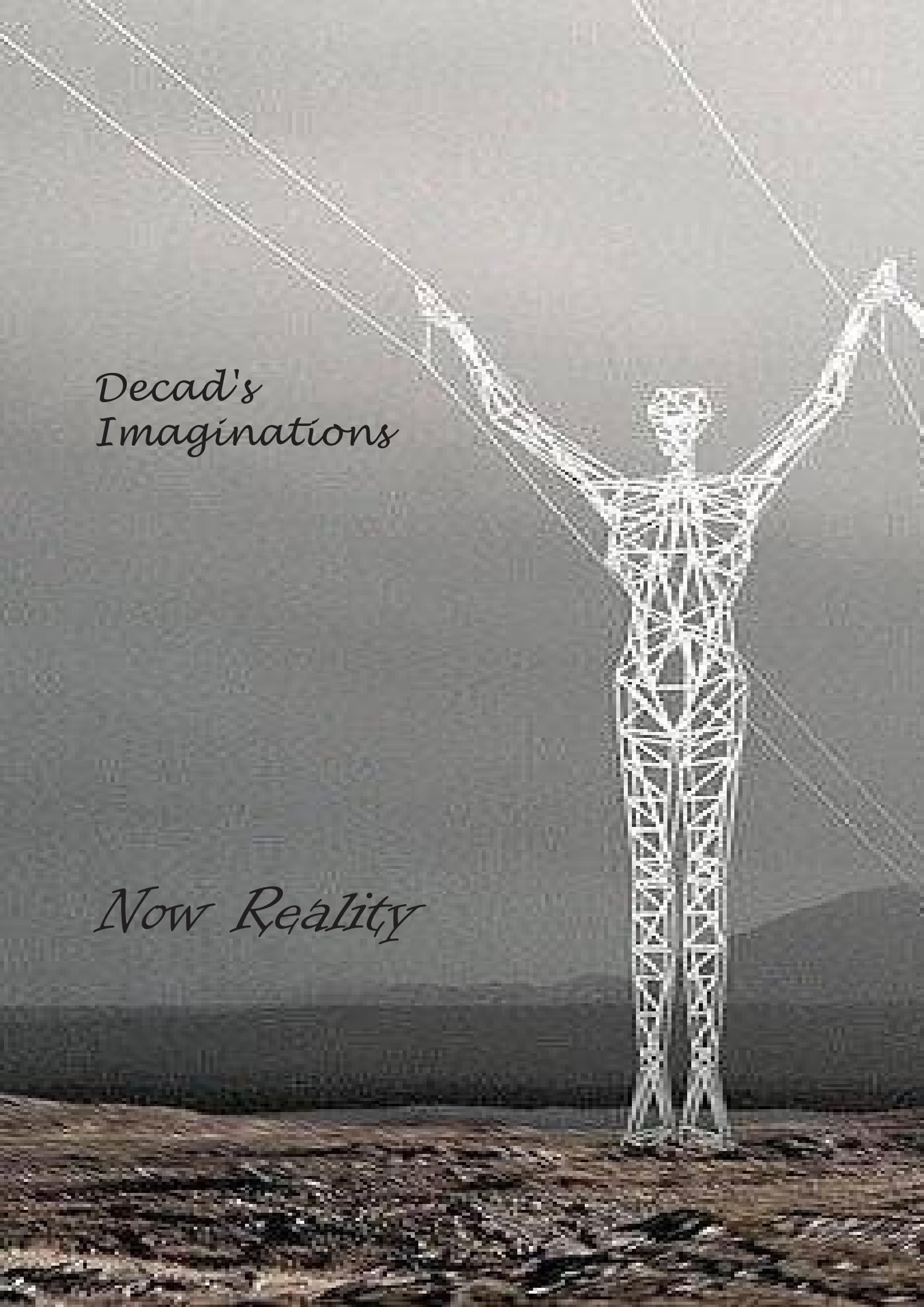

Decad's
Imaginations
Now Reality

Pakistan Engineering Council & Washington Accord

Engr. Naveed Ahmed Unar

Pakistan Engineering Council recently became a signatory of the world's biggest engineering platform i.e. Washington Accord. However, majority of the universities and higher education institutes in Pakistan offering admissions in engineering oriented disciplines failed to make a mark before the adjudicating panel owing to lack of commitment in meeting deadlines for laying a comprehensive output based education system as proposed by the Higher Education Commission of Pakistan. . As a result of this, less than 20% of the Pakistani universities' engineering programs have been successfully recognized.

Pakistan Engineering Council or PEC is a regulating Federation for the engineering profession in Pakistan. Recently PEC signed historic Washington Accord and became a full signatory of the highly prestigious international forum for International Engineering Alliance. The agreement was penned down in General Assembly meeting held in the United States on June 21, 2017. So far only eighteen countries have achieved this milestone in the last twenty-five years. Pakistan thus far is the 19th country and 3rd Islamic country after Malaysia and Turkey. Having said that, it is quite unfortunate and disappointing at the same time to learn that only handful of Pakistani universities with selected programs have been recognized by Washington Accord. Some of these universities are National University of Science and Technology, NED University of Engineering and Technology, Ghulam Ishaq Khan Institute of Engineering, Sciences and Technology and Lahore

University of Management Sciences. It is however highlighted that not a single engineering university from Sindh, Balochistan and KPK excluding NED University and GIKI has made it to the final spot which implies that most of the universities have failed for a successful review of the Output Based Education System (OBE) implemented by the Higher Education Commission and Pakistan Engineering Council for strengthening the standards of accreditation in universities. This is indeed an indication of below par performance from HEC and PEC management and the representatives of the various universities who could not implement OBE effectively in due course of time and failed to impress before Washington Accord elite panel.

O-Engineers Editorial Team Point of View:

This is the open forum for all engineers, but we are not responsible for any engineer's opinion. We also Want to be neutral in any argumental debate.

From Linkedin

Rebecca Weeks Watson
Digital media entrepreneur

"I was a CEO at the top of the tech world. The next day I'm dying of a heart attack, and the next day I'm unemployed. No ambition, no nothing...at rock bottom. But sitting there in critical care, I realized I had nothing to lose. That's when I decided the greatest thing I could do for the world is get up, give back, teach, and inspire."

2KW/ Human

Engr. Qazi Arsalan Hamid

Bill Gates the Microsoft founder announced in 2016 that within 15 years we will have complete clean energy but it is not possible without the involvement of young peoples.
Is it really true? Do we have to wait another 15 years?
No my argument is No, our world and respective government understood the need for clean energy, they knew how much they already had damaged our weather by making a lot of coal burned and gas fueled plants. We are destroying our world by our own hands! But again nature told us that it has a solution. Wind Energy and Solar Energy!

Let's Talk Solar, is this a new technology?
Again hell no, more than a half century past of this technology awareness, in 1958 Vanguard-1 the 4th satellite ever to launch in space carried 6 Photovoltaic Panels. Each panel rating was half Watt, the purpose of this panel was to power up the particular communication system of satellite, this communication system was sending weather data or better we say climate comparison data back to Earth for next 6 years!
Initially, this technology was so costly, imagine $1000 per watt (ouch), but by passing years this energy panels also devalued in term of money, in 1970 it was $100 per watt, nowadays it is around 50 cents/watt.
Germany is working on reduction of solar energy, optimistically 3.2 pence/ kilowatt, they have a solution Solar Parks (Proposed by German research institute Fraunhofer). Germany is 1st world economy, and 2nd largest economically well-developed country, now question is that is the same sort of research is carried out in 3rd world poor countries when we have more exposure to solar energy than European countries? Just think about it!
Why we need solar panels to light our dark valleys?

- It can be manufactured at very low

Vanguard 1 was inspected by GPS Pioneer Robert L Easton (Left)

cost.

- It is almost maintenance free
- It is reliable and long lasting

source of energy at this time
Typical panel life is 35 years, your return on investment of this source of energy is less than most of the items right now.
But we need to listen critics also, now 1st of all understand it is a day only source of energy, so what we need to do, we must include charging the battery whenever think about solar panel. We must say "here comes the pain"
Now our cost will be like Solar panel + Battery+ battery maintenance, if the load at home is big then papa need to bring big energy storage batteries at home. Big storage batteries mean big amount. Now, who has the solution for this issue, one thought is that engineers knew the solution when they understand the problem, so here come Tesla Company, they are working on cost reduction of big capacity batteries. Tesla aim is to reduce the cost of a battery with respect to panel cost (hurrah). They are working on it. Just think 3.2pence/Kilowatt generate by the panel and our 10-kilowatt battery cost is around $40, what we need then?
Many organizations of the world are working seriously on carbon free and cheap energy concepts. AGL of Australia, ENGIE of France and UK's Electricity Trade Association already start working on energy shift. AGL sold its complete gas business, ENGIE gets rid of its Coal Plants and UK's Electricity Trade association also working on getting rid of coal power plants.
Do mankind succeed to get rid of power sources which are affecting our earth and pockets?
Now let's see what we are losing?
You knew what is earth inhabitant complete power consumption?

We are inventing the Armageddon which our ancestor predicted.

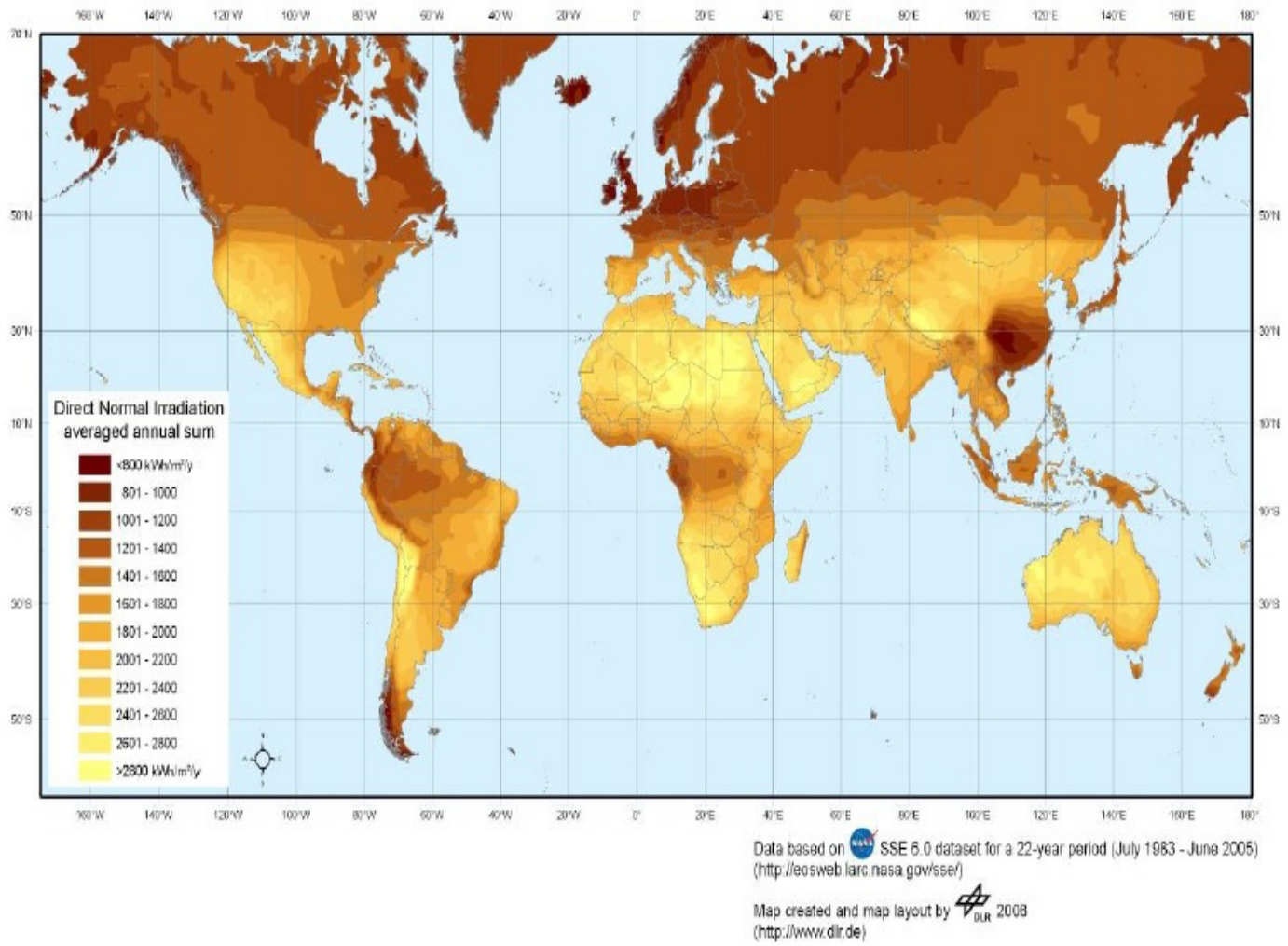
15-16 terawatt at any time, but remember 18% of mankind do not have electricity at home. Now you know how much solar energy we are receiving from the sun per year?
90000 terawatt!
Either Developed or underdeveloped both need energy, both are searching ways of getting it from fossil fuels in recent history, it was not a long time ago that China was building two coal plants/week. Why?

But let me clear one point it is not their fault they just want to fulfill their industries requirement by their immediate available resources, now China also serious about solar power generation, many of Asia largest solar panel manufacturers are operational in China. They build coal and gas plants rapidly and in numbers so they can move along with demands of their industrial growth. But this all means industrial growth is unintentionally like a death to our kind earth. We are inventing the Armageddon which our ancestor predicted.

Although we are receiving 90000tera watt from the sun, our panels efficiency is about 20%, as per one estimation earth inhabitants will require 30tera watt by 2050, so if we want to fulfill this requirement we need 150tera watt power plant capacity. Critics asked Do we have space for this much amount of plants on our earth? let analyze, as per estimation we need one solar farm to generate 1Megawatt of Power, and the solar farm will cover around 2 hectares or 5 acres of a landmass. There is 1 million megawatt in 1 terawatt, so we need 2 million hectares for 1 terawatt and for 150 terawatts we need 300million hectare.

This 300 million hectare is genuinely 1% of earth landmass, we need only 1% of earth mass to save our earth and also fulfill our energy requirement. Some experts shows marks on distant area from load centers and place idea about installation of solar panels on the marked areas this is totally wrong, this solution will raise the cost of solar plant's energy because of long transmission line installation that is why these solar farms or panels installation is recommended as near as possible to load centers, but again this is an issue, we cannot recommend it in crowded countries like India, Bangladesh, Pakistan and China as they do not such landmass available near to transmission lines or load centers due to dense population so as compare to European and American continents they need the number of panels or solar farm as per one comparison else their transmission line costs and line losses will increase significantly.

Increased number of panels issue will be resolved, in 1960 Boston consulting group investigated the cost vs production trend of semiconductor panels. They found 25% cost reduction when production was doubled. They called it experience curve.



Experience curve applied in the Computer industry, Telecom Industry so why not in solar panel and battery industry but remember experience curve fails to apply in the industrial sectors where safety is required significantly like Nuclear power plants. In solar panel industry this safety factor is not as costly as nuclear plant industry, and experience curve will be easily applicable in this industry, we can say more experienced we will gain in panel manufacturing, more PV panel we will get at a low price.
We also have one law for Photovoltaic Cost prediction, which is called Swanson Law, which proposed 20% reduction in cost effect in doubling year. Means if in the UK on one school rooftop 10Kilowatt installation cost 10000 pounds today, then after two years, the cost of installation will be 8000 pounds. Swanson law called it learning curve effect.
We will continue this discussion in further editions, and explore more aspects in solar power generation field.

Energy Audit

Engr. Tuseef Ahmed Khan

ENERGY Audit is a systematic assessment of energy flows in and out of a system and its usage pattern towards achieving energy conservation without negatively affecting the outputs. Energy inputs at the point of purchase, energy losses, and energy end use are assessed for the conservation of energy and cost savings through efficient and effective utilization of energy.

Conducting an energy audit will not only get you started on your energy management program, it will get you significant savings.

In OUR COMPANY we do audit of power factor at all load level and load flow studies on simulation software, power generation load factor audit and losses calculation etc.

An audit is designed to determine where, when, why and how energy is being used. This information can then be used to identify opportunities to improve efficiency, decrease energy costs and reduce greenhouse gas emissions that contribute to climate change. Energy audits can also verify the effectiveness of energy management opportunities (EMOs) after they have been implemented.

Purpose of Energy Audit is to achieve Energy Conservation and Cost Reduction, resulting in most of the cases is a reduction of GHG emissions.

Rising cost of energy inputs will increase its importance further as the cost of Energy Audit and its Implementation costs are becoming attractive as compared to cost saving.

The following must be done/ prepared before starting Energy Audit of an Industry

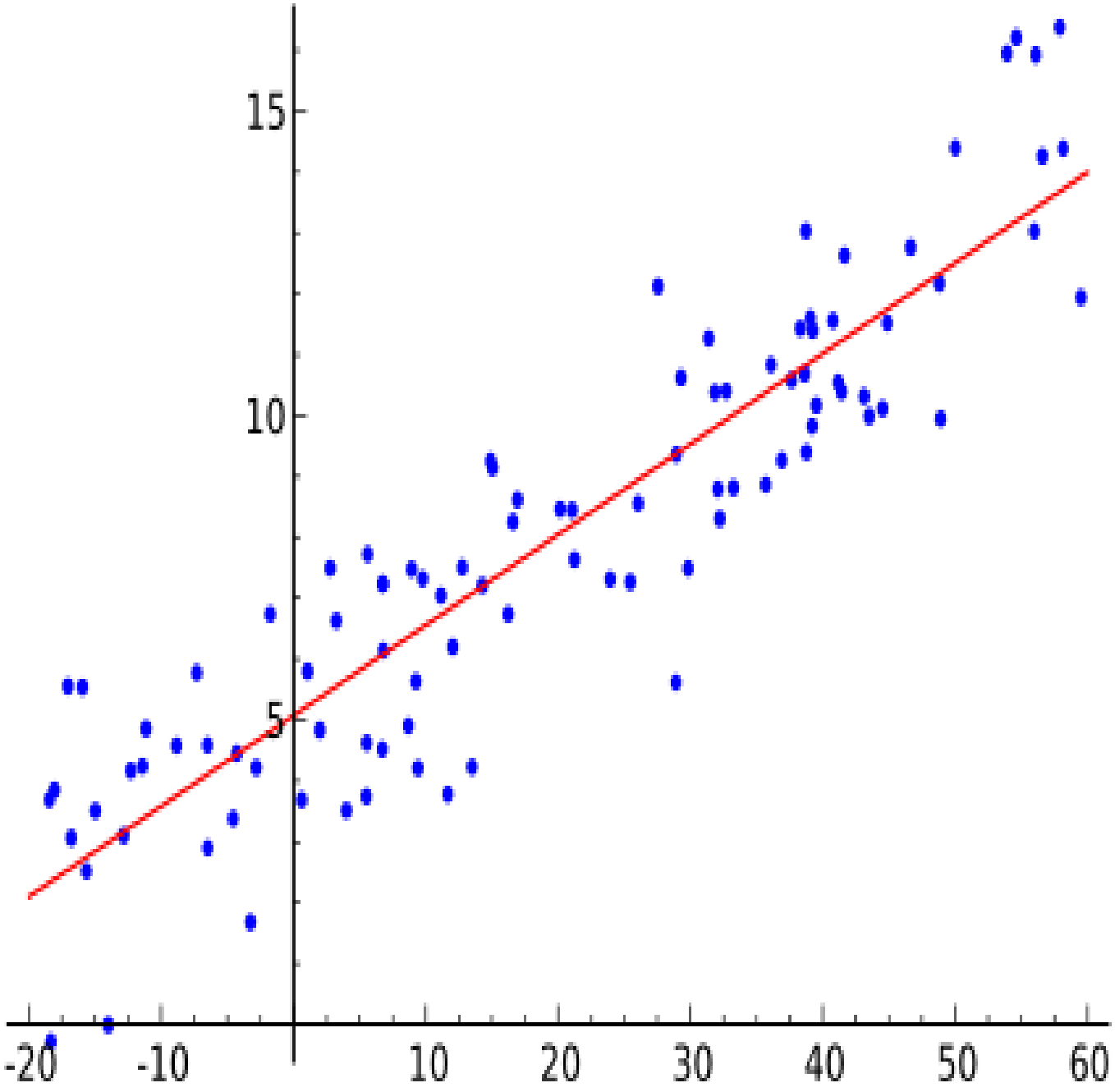
a. Condition Survey

b. Audit Plan – including audit mandate and scope, schedule of activities, audit team, report format

c. Coordination with Stakeholders/Departments – taking all departments involved on board for effective communication

d. Identification of Resources – whether internal auditors or external consultants, unbiased report to be ensured.

Regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'Criterion Variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables – that is, the average value of the dependent variable when the independent variables are fixed.



Condition Survey gives awareness of facility and its major energy uses.
It gives an idea of the further requirement of assessment.
Identifies areas in need of EMOs
Helps to establish audit mandate and scope
Identifies obvious opportunities of energy savings that can be availed with little capital / further assessment.

Is there any difference between a kWh of electric power and kWh of heat? If yes then describe in the context of Karachi?
KWh of heat (KWh-th) is the input of energy to produce KWh electricity (KWh-e)
KWh heat is always more than KWh electricity due to losses in process of production of electricity.
A ratio of KWh-e / KWh-th is called Thermal Efficiency of the System.
In Karachi heat input to power generation plants is either as Natural Gas or Heavy Fuel oil.

There are open and combined cycle plants having efficiencies ranging from 35-45%
Average efficiency is taken as 40% therefore
th = KWh-e / KWh-th = 40%
KWh-e (grid) = 0.4 KWh-th OR
KWh-th = 2.5 KWh-e (grid)
To produce 1KWh-e at the Grid, 2.5KWh-th are needed at the input of Power Generating Units
If a 30% loss of T & D is also taken then the KWh-e at the end user will be further reduced by 30%
KWh-e (consumer) = 0.4 x 0.3 KWh-th = 0.12 KWh-th or 12% of KWh-th
KWH-th = 1/1.2KWh-e (consumer)
Or for producing 1KWH-e at the consumer end, 8.33 KWh-th are needed at the Input of Power Generating Units.
This makes T & D Losses of prime importance in Energy Audit of OUR COMPANY.

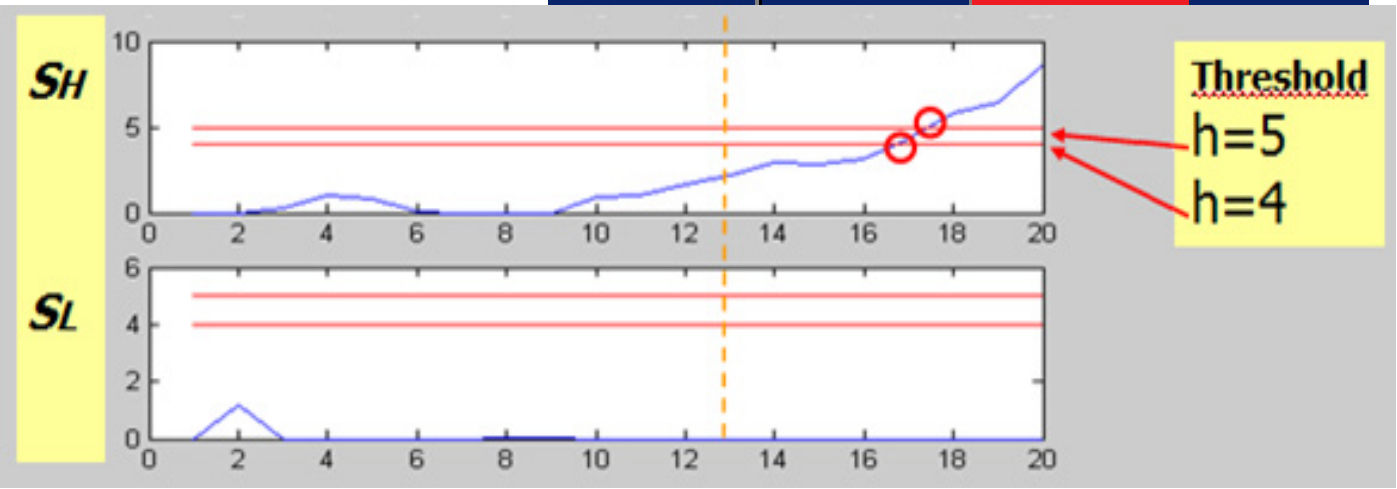
Energy monitoring involves measurements, analysis, comparing with benchmark/target, information system and taking appropriate actions for maintaining a target pattern or improvement.
At HUB Power Station Daily Electricity Production and Consumption of Fuel (RFO) is monitored on an hourly basis and Heat Rate (HR) in Kcal/ KWh is calculated and its behavior is compared with target Heat Rate. Target Heat Rate is that which should be as per Power Purchase Agreement.
Management then applies another target to achieve a further reduction in HR to achieve Efficiency Bonus.
There is another simple factor for Management Control, called OPAL Factor that monitors Operational Performance and Losses and gives a factor which indicates how close we are to target efficiency. 100% OPAL Factor means target efficiency is achieved.

Cumulative sum (CUSUM) analysis is carried out to determine the deviation of energy in a facility/ industry.

Periodic Energy Consumption against Production is tabulated.
Period can be e.g. hour/day/week/month/year
Specific Energy is calculated in KWh/ Unit of Production in respective periods
For same productions Predicted / Target Energy Consumption is also tabulated on respective periods
Difference between Actual and Predicted / Target Energy Requirement are calculated and entered as Difference of Energy.
This difference can be positive or negative.
Positive means more energy is consumed as compared to the target and vice versa.
The difference of energy of first readings is added in a difference of the second set of readings and this then added to the difference of third reading set and so on to give a Cumulative Sum of Differences, called CUSM.
If CUSUM is zero, energy usage is on target - ok

If it is negative, energy used is less than target – good
If it is positive, energy usage is more than target—need corrective action
To know when to take corrective action, a trend is plotted between Periods and CUSUM.
Deviations in trend indicate effects of corrective actions and if no action then the direction of usage of energy to take corrective action.
The following example shows 15 observations of a process with a mean value of X 0 and a standard deviation of 0.5. It can be seen as the value of Z is never greater than 3, so other control charts should not be detected as a failure while using the Cusum 17 that shows the value of SH is greater than 4.

X	Z	Sh	Sl
-0.60207	-1.2041	0	
-0.85543	-1.7109	0	1.210
0.4084	0.8168	0.3168	
0.60292	1.2058	1.0226	
0.14554	0.29107	0.81371	
-0.11812	-0.23625	0.077457	
-0.22425	-0.44851	0	
-0.25985	-0.5197	0	0.01969
-0.26579	-0.53158	0	0.05127
0.70213	1.4043	0.90426	
0.32766	0.65532	1.0596	
0.55666	1.1133	1.6729	
0.50528	1.0106	2.1835	
0.62256	1.2451	2.9286	
0.21262	0.42524	2.8538	
0.36577	0.73153	3.0854	
0.85273	1.7055	4.2908	
1.0159	2.0318	5.8226	
0.53494	1.0699	6.3925	
1.4023	2.8045	8.697	



During the progress of the project, the team has identified that in order to proceed to the third step of the methodology (offsetting) there is a need to generate the energy demand profile of the community being analyzed? The energy demand profile is essential in the offsetting procedure, in order to ensure the proper sizing of the Renewable Energy supply.
Unfortunately, the majority of the R.E applications are using the National-Typical demand profile which is not taking into consideration the diversification in demand different communities might have. The team has identified that the energy demand profile can vary significantly among communities due to several reasons. The most important are presented below.

Energy Demand (E.D.) A tool that was developed to generate the electricity demand profile of a whole community or plant etc. The code is based on probability models that predict the possibility of each household to operate a certain amount of appliances on a certain time of the day for different end users (occupancy types). The tool was originally designed to provide quick and accurate results about the electricity demand of a single household as well as the whole community.
The Energy Demand Profile (E.D.p) tools' only inputs are (UK):

- The Census Demographic results, which are available for every community in the UK.
- The annual electricity consumption, which can be obtained simply by making an inquiry to the utility company that serves the community.

The tool is using an hourly step calculator, but we believe this is enough to provide a rough estimation of the daily electricity demand.

This all tools and methodology are prescribed for monitoring, controlling and scheduling the energy use at an optimum level

However, this tool can be developed even more to implement an, up to, five minutes time step so that the results can be used directly to introduce a

community CHP scheme.
Heating Demand profile generator (H.D.p) (use it online) is a tool that was developed to generate the Heating Demand profile.
This all tools and methodology are prescribed for monitoring, controlling and scheduling the energy use at an optimum level.
The demand profile is the electrical fingerprint of a facility's electrical consumption patterns. Key information can be obtained by reading or interpreting the profile. This includes loads that operate continuously and that could be shut down, loads that contribute unnecessarily to the peak demand, and loads that are operating abnormally and require maintenance. Many electrical loads leave behind very distinct fingerprints as they operate. By recognizing the patterns associated with each component, it is possible to identify the contribution of various loads to the overall demand profile. Interpreting a demand profile is not just science (technical skill) – art (interpretative skill) is involved too. Good knowledge of the facility, its loads, operational patterns and the examples in this section should provide a solid basis for developing that interpretative skill. Step 1 It is useful, to begin with, a list or inventory of electrical loads within a facility. Section 7 describes a method of compiling such a list. Step 2 Study the demand profile and circle or make a note of all the significant occurrences, such as n abrupt changes in demand n the top three peak demands n repeated patterns n flat sections n dips during peak periods n minimum demand level This is only a partial list; every demand profile is different. Mark anything that appears to be significant.

Step 3 Mark along the time scale the time of day when significant operational events occur. Such events include:
n start-up and shutdown n coffee breaks n lunch hour n shift changes n other notable events (operation of a specific process) the purpose here is to spot some correlation between the features noted in Step 2 and work patterns in the facility.

Demand profile is the electrical fingerprint of a facility's electrical consumption patterns

Power Factor Correction equipment can reduce your business's electricity bills through lower monthly maximum demand and capacity charges. What's more, if your electrical system is near capacity, installation of Power Factor Correction equipment can help avoid costly upgrades by lowering the demand on your system.

Power factor is a measure of how effectively you are using your power and is measured between 0 and 1 (1 being the perfect score). You should find this value printed on the bill from your energy retailer. Depending on your usage patterns, it will vary from month to month. If you are regularly scoring less than 0.9, you have a low power factor, in which case you are likely to be paying for more electricity than you need.

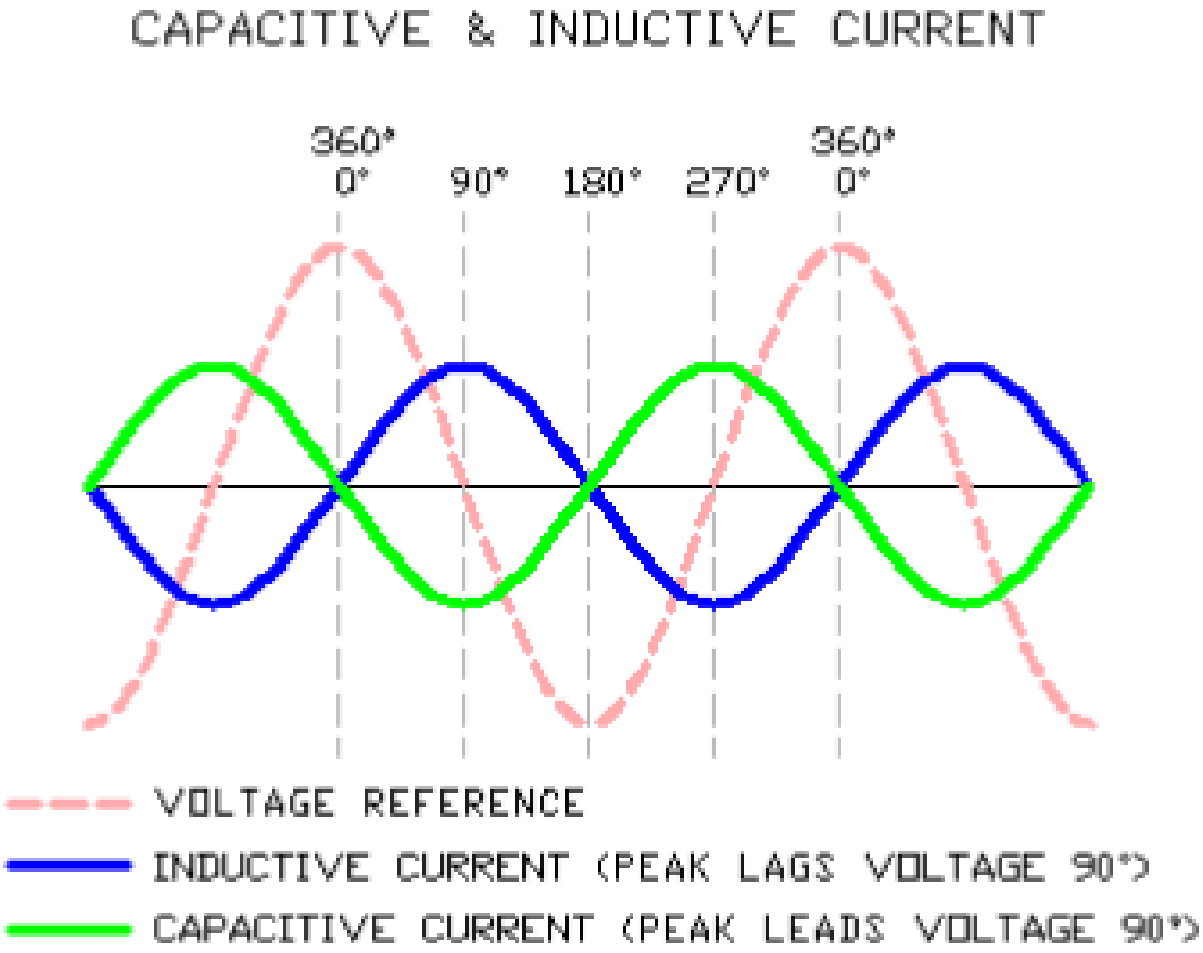
Low power factor is improved by installing power factor correction (PFC) equipment. These are capacitors which work as silent reactive power 'generators' so the total amount of electricity demand decreases. These capacitors are housed in a metal cabinet, similar to the one that houses your electrical switchboard, and is often located beside it.

If your power factor is low, power factor correction equipment can reduce your electricity bills through lower monthly maximum demand and capacity charges. And if your electrical system is near its capacity, installation of power factor correction equipment can help avoid costly infrastructure upgrades by lowering the maximum electrical demand on your system.

The cost of power factor correction equipment varies depending on the nature of your business and its size. There is a capital cost for this installation but don't panic – expected payback periods are provided in all our quotes and are typically between 1 and 3 years.

The simple quick answer is power factor correction does little to reduce KWh usage. There are some cases where applying power factor correction for an industrial/ commercial facility is cost effective. The main incentive for power factor correction is avoiding a low power factor penalty from utility companies. There are some other benefits from power factor correction, which are explained in this article. It is important that before you take the step to install power factor correction you

should know that adding capacitors to your electrical system may unintended consequences to both capacitors and the existing system. There are two types of reactive power, inductive and capacitive. Inductive loads store energy in a magnetic field. The peak current draw for an inductive load lags voltage peak by 90 degrees. A capacitive load stores energy in a magnetic charge. The peak current draw for a capacitive load leads voltage peak by 90 degrees.



Load inventory is basically the method of logging all energy consumption point to log that where energy is being used and how much it is being used.

Now we outline a method for compiling a loaded inventory using forms, samples of which are shown below. The forms contain instructions. In addition to these forms, a clipboard, pencil, and calculator are required. Instrumentation is not a necessity; a simple clip-on ammeter is probably adequate in most situations. Other instrumentation is discussed in Section C-2.Step 1 The following information is required: A period of time on which the inventory will be based, usually a month,

corresponding to the utility billing period; it could also be a day, week or year. Select a period that is typical of your operations. Determine the actual demand in kilowatts (kW) and the energy consumption in kilowatt-hours (kWh) for the period selected. If the period selected is a month, information is available from the utility bill. If the facility demand is measured in kVA, this will require a calculation based on the peak power factor to convert kVA to kW. (See “Energy Fundamentals” for details.) Record the actual values on Summary Form LD1, as “Actual Demand & Energy".
Step 2 Identify each of the major categories of electricity use in the facility. You may have to take a walk through your facility and list categories as you notice them. Record each category on Form LD1. When identifying the various categories of use, it is useful to consider both the type of electricity use and the activity in each area.Selecting categories with similar operation patterns is a good approach. The example on the sample form separates the motor use from the lighting used in the office, production (multiple categories) and exterior areas.

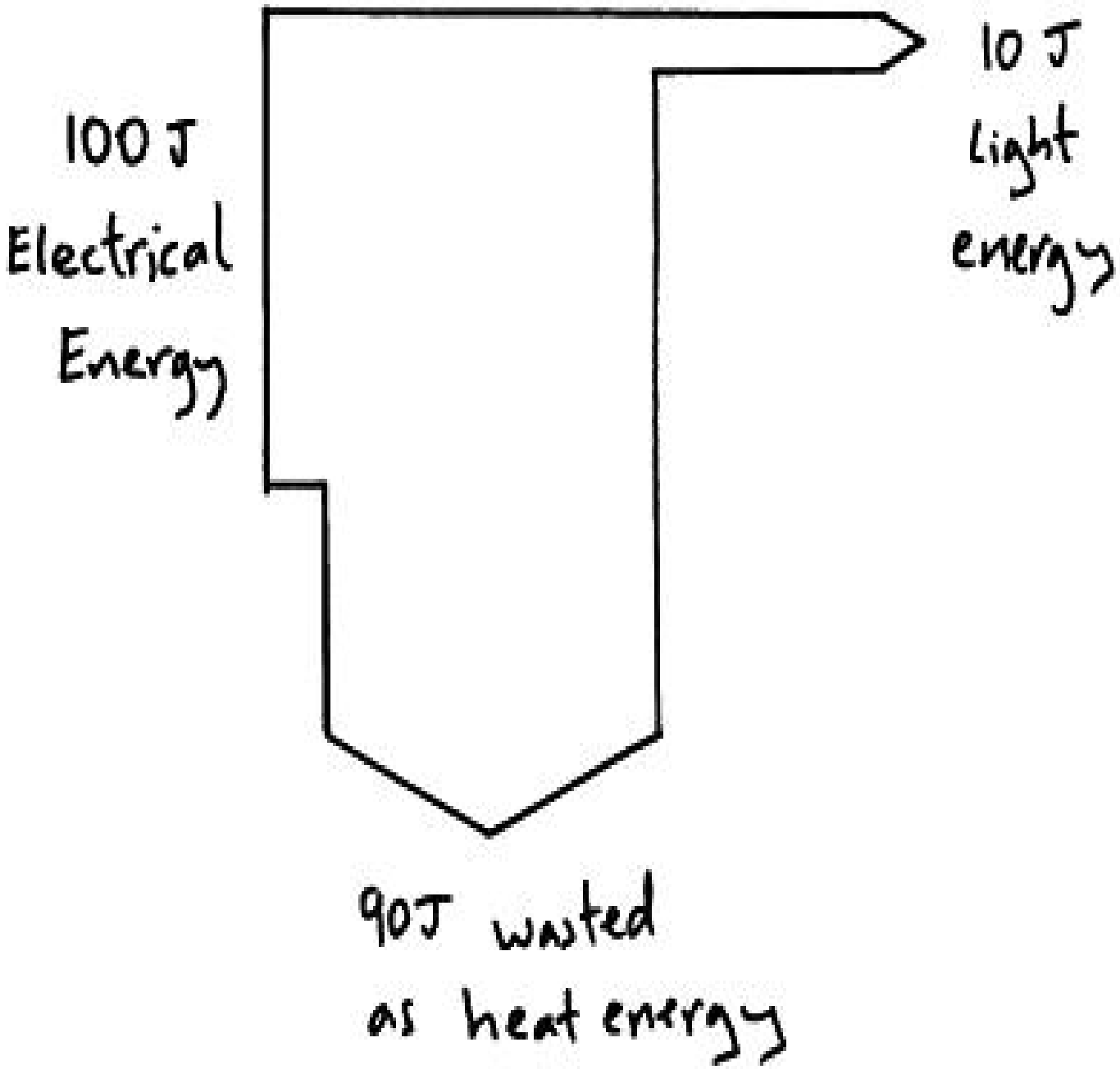
Step 3 Guess the percentage of demand attributable to each category. This may be based on prior knowledge, a rough idea of the size of the loads, the size of the distribution wiring, etc. You can also use any information available from the demand profile when preparing this estimate. Record the demand percentages on Form LD1 and calculate the estimated demand for each category of use based on the actual demand.
Step 4 Guess the percentage of energy used in each category. This should be based on occupancy, production, or other such factors relating to the intensity of use in each category. Record the energy percentages on Form LD1 and calculate the estimated energy for each category of use based on the actual energy. Step 5 Select the category of largest demand or energy use.

Energy balance means that energy input to the system will be equal to the energy output of the system
Example 01:
Our nutrition in a body is the best example we eat food and energy consumed in a different part of a body and some stored.

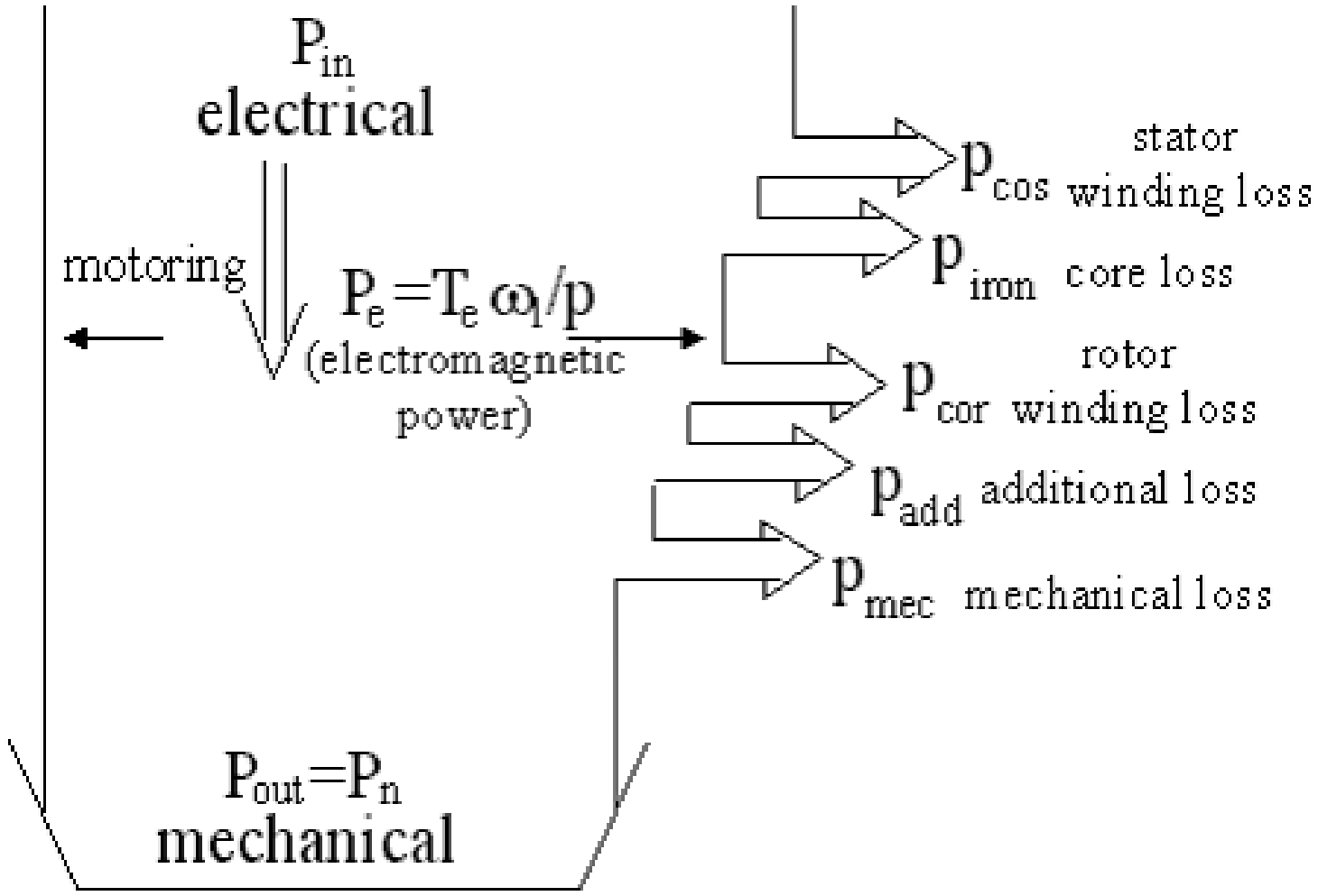
Example 02:
Our cars are the best example for that we used fuel as input and in output we have mechanical power, heat loss, friction loss etc.

Example 03:
Hand pump installs on well is another example of the energy balance as we use human body power and as a result of which water sucked.

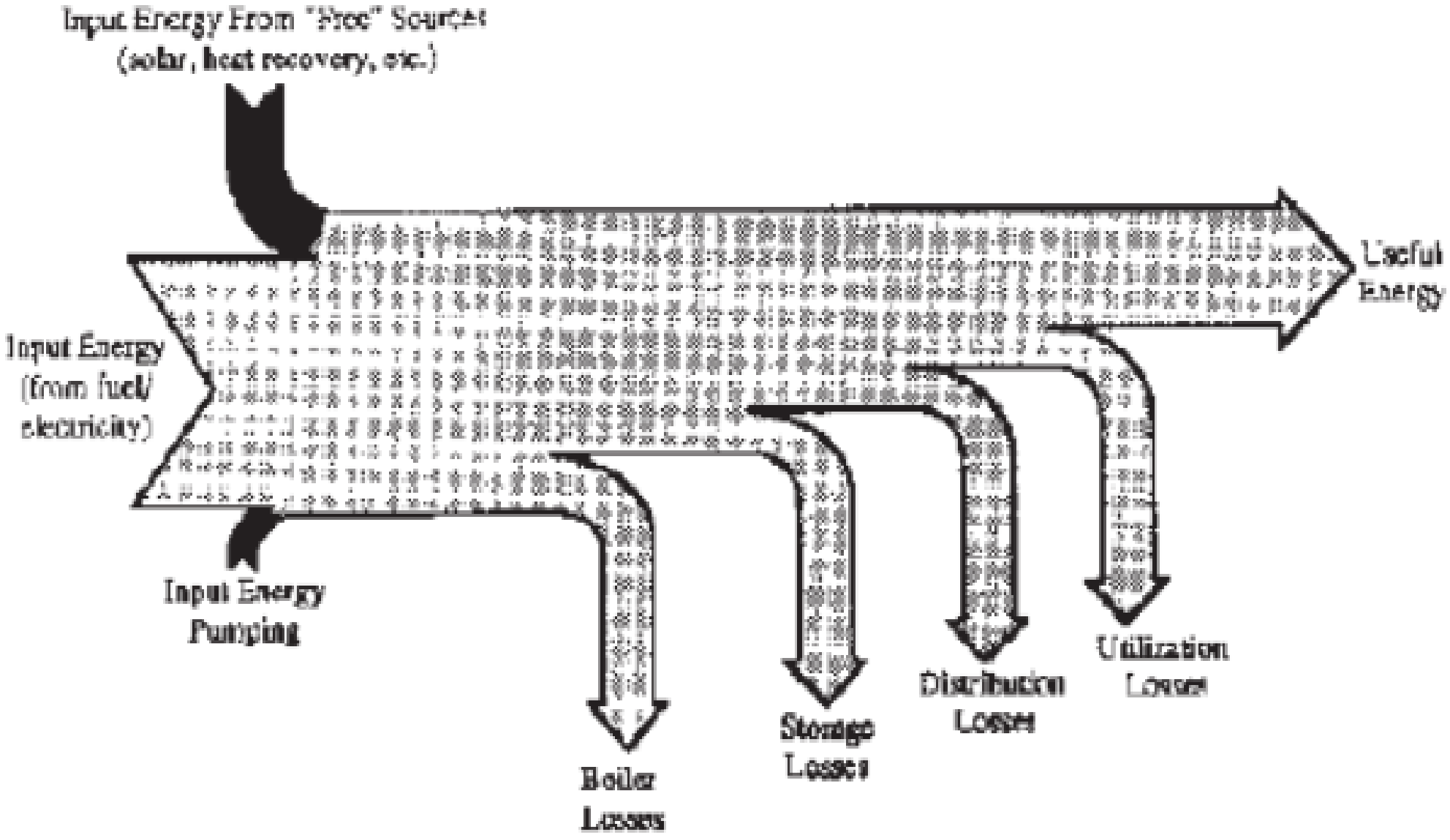
Below is the Sankey diagram for a filament bulb. The 100 joules of electrical energy is transferred into 10 joules of useful light energy and 90 joules of wasted heat energy.



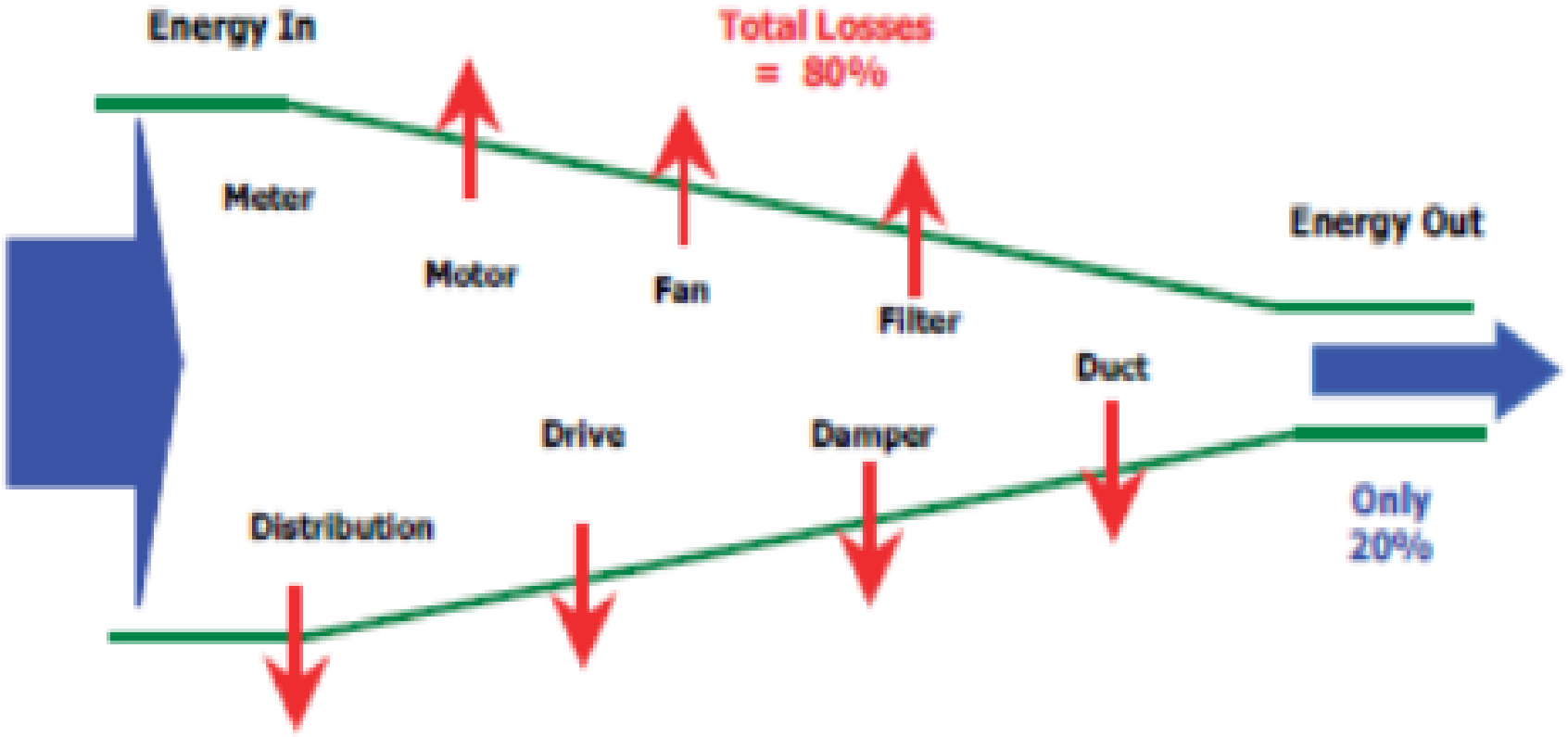
Sankey Diagram of Energy Balance for an Electric Motor



Sankey Diagram of Energy Balance for Heat Exchanger



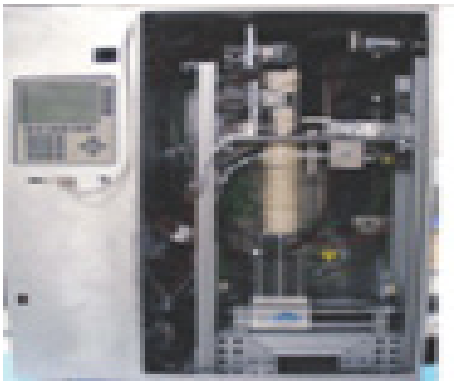
Sankey Diagram of Energy Balance for blower/Fan



Different kind of instrument employed in energy audit

Electrical Instruments: These are instruments for measuring major electrical parameters such as kVA, kW, PF, Hertz, kVAr, Amps and Volts. In addition, some of these instruments also measure harmonics. These instruments are applied on-line i.e on running motors without any need to stop the motor. Instant measurements can be taken with hand-held meters, while more advanced ones facilitates cumulative readings with print outs at specified intervals.Details of Low cost Energy Audit Tool (PEAT) - Mr. R K Mohan Rao, Scientist-in-Charge, CSIO Chenn Unit

Combustion analyzer: This instrument has in-built chemical cells which measure various gases such as O2, CO, NOX and SOX.



Fuel Efficieny Monitor: This measures oxygen and temperature of the flue gas. Calorific values of common fuels are fed into the microprocessor which calculates the combustion efficiency.

FLUE GAS ANALYZER: A hand bellow pump draws the flue gas sample into the solution inside the fyrite. A chemical reaction changes the liquid volume revealing the amount of gas. A separate fyrite can be used for O2 and CO2 measurement.

Thermometer: Contact Thermometer: These are thermocouples which measures for example flue gas, hot air, hot water temperatures by insertion of probe into the stream. For surface temperature, a leaf type probe is used with the same instrument.
Infrared Thermometer: This is a non-contact type measurement which when directed at a heat source directly gives the temperature read out. This instrument is useful for measuring hot spots in furnaces, surface temperatures etc.

Manometer:
Air velocity in ducts can be measured using a pitot tube and inclined manometer for further calculation of flows.

Water Flow Meter:

This non-contact flow measuring device using Doppler effect / Ultra sonic principle. There is a transmitter and receiver which are positioned on opposite sides of the pipe. The meter directly gives the flow. Water and other fluid flows can be easily measured with this meter.

Speed Measurement:

In any audit exercise speed measurements are critical as they may change with frequency, belt slip and loading. A simple tachometer is a contact type instrument which can be used where direct access is possible. More sophisticated and safer ones are non-contact instruments such as stroboscopes.

Leak Detectors:

Ultrasonic instruments are available which can be used to detect leaks of compressed air and other gases which are normally not possible to detect with human abilities.

Lux meter:

Illumination levels are measured with a lux meter. It consists of a photo cell which senses the light output, converts to electrical impulses which are calibrated as lux.

Energy conservation Vs Energy efficiencies:

Energy conservation refers to reducing energy through using less of an energy service. Energy conservation differs from efficient energy use, which refers to using less energy for a constant service. For example, driving less is an example of energy conservation. Driving the same amount with a higher mileage vehicle is an example of energy efficiency. Energy conservation and efficiency are both energy reduction techniques.Even though energy conservation reduces energy services, it can result in increased financial capital, environmental quality, national security, and personal financial security.[1] It is at the top of the sustainable energy hierarchy

Energy demand management

Energy demand management, also known as demand side management (DSM), is the modification of consumer demand for energy through various methods such as financial incentives and education. Usually, the goal of demand side management is to encourage the consumer to use less energy during peak hours or to move the time of energy use to off-peak times such as nighttime and weekends.[1] Peak demand management does not necessarily decrease total energy consumption but could be expected to reduce the need for investments in networks and/or power plants

Tendering talk

Tendering Engineer's Interview Questions

Engr.Qazi Arsalan Hamid

Tender Engineer must have a knowledge of below-asked terms.

- What is proposal stage of tender?

It is initial documentation of tender, in which the high demand requirements of tender need to be finalized, this we will extract from Tenders

- Define the role of the tender engineer?

It changes company to company but, generally tendering engineer's primary role is to understand Technical requirements of customer from Tender documents and pass them on to Commercial team for costing, also be a bridge between sales, contract & customer to understand Technical requirements and evaluate them. Also, clarify working team's technical queries and discuss with the customer also if needed.

- What is method statement?

A work method statement sometimes called a "safe system of work", is a document that details the way a work task or process is to be completed. The method statement should outline the hazards involved and include a step by step guide on how to do the job safely.

- What is Technical Proposal?

A document that lists and defines the technical requirements of a contract or project, and explains the approach and plan formulated to address them.

Tendering engineer's primary role is to understand Technical requirements of customer from Tender documents

- What is Work scope?

The Scope of Work (SOW) is the area in an agreement where the work to be performed is described.The SOW should contain any milestones, reports, deliverables, and end products that are expected to be provided by the performing party. The SOW should

also, contain a time line for all deliverables.

- What are Forms of Tender?

Forms of Tender and Schedules (Works) The Form of Tender and Schedule are issued as part of the tender documents. The Form of Tender is a form where the tenderer can fill in details relating to their offer, including the lump sum for which they are offering to complete the works.

- What is the form of Contract?

Forms of Tender and Schedules (Works) The Form of Tender and Schedule are issued as part of the tender documents. The Form of Tender is a form where the tenderer can fill in details relating to their offer, including the lump sum for which they are offering to complete the works.

- What is Tender Pricing Document?

The tender pricing document sets out the way in which the design team and client wish to review the breakdown of the overall tender prices provided by tendering contractors. ... Identify any significant differences in pricing between tenderers to ensure the design has been correctly interpreted.

Work Flow of Tender

Tenders documents may include:

1. A letter of invitation to tender.
2. The form of tender.
3. Preliminaries: including pre-construction information and site waste management plan (if required).
4. The form of contract, contract conditions, and amendments. This might include a model enabling amendment for building information modeling (BIM), making a BIM protocol a contractual document.
5. A tender pricing document (or contract sum analysis on design and build projects).
6. Employer's information requirements for BIM.
7. Design drawings, and perhaps an existing building information model.
8. Specifications.

Note: This is the 2nd part of our tendering article series, we will continue it in next month issue also.

Engineer Making Differences

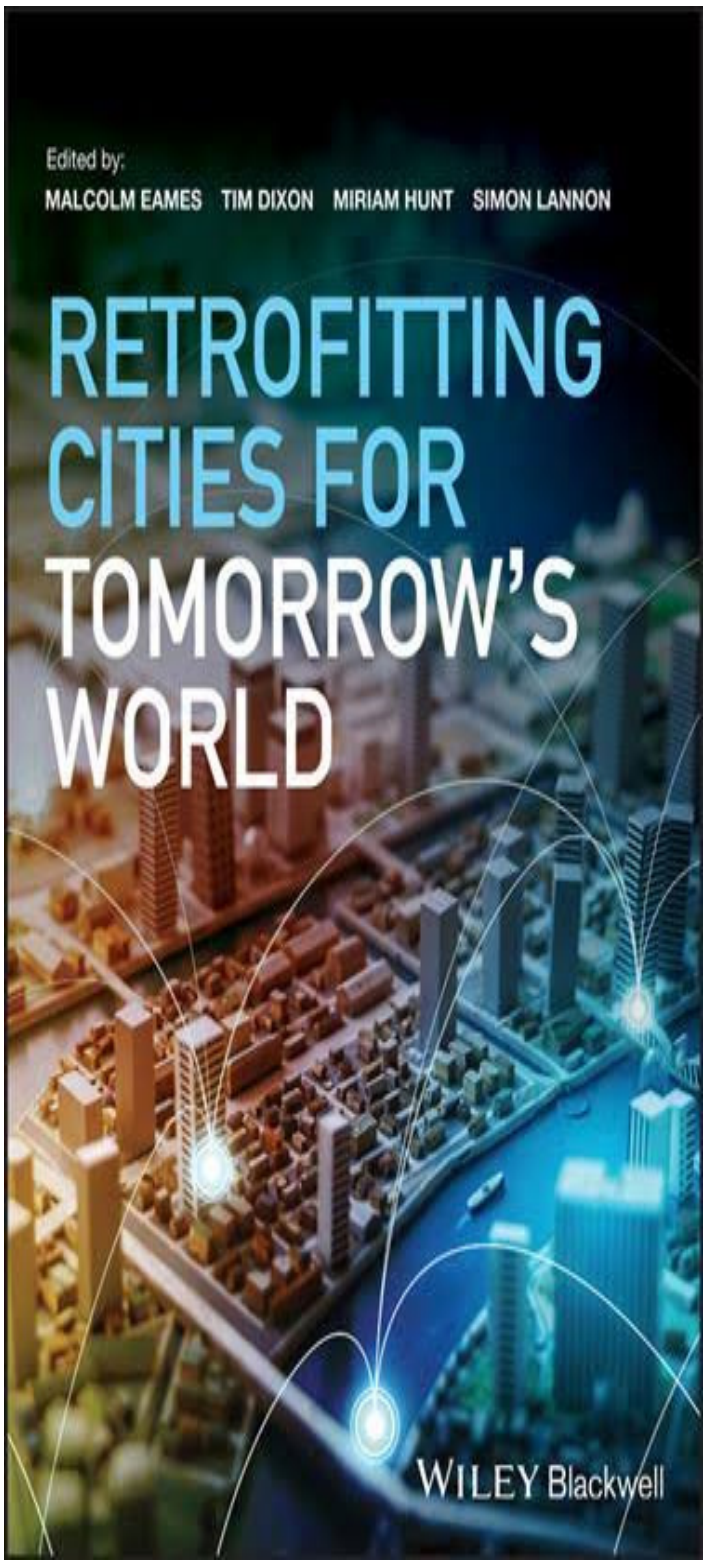
(Engr.Saud Amin)

By Education Saud is Mechanical Engineer,
He served in Pakistan Airforce Engineering Wing, Nowadays spending his time and efforts for Students skill development and youth Counselling. Saud is also active in social services and involved in multiple society development initiatives.

Book of the Month (Editorial Team)

Refrotting Cities For Tomorrow's World

A groundbreaking exploration of the most promising new ideas for creating the sustainable cities of tomorrow
The culmination of a four-year collaborative research project undertaken by leading UK universities, in partnership with city authorities, prominent architecture firms, and major international consultants, Retrofitting Cities for Tomorrow's World explores the theoretical and practical aspects of the transition towards sustainability in the built environment that will occur in the years ahead. The emphasis throughout is on emerging systems innovations and bold new ways of imagining and re-imagining urban retrofitting, set within the context of 'futures-based' thinking.



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